

Maine Space Grant Consortium
Lead Institution: Maine Space Grant Consortium
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Maine Space Grant Consortium is a Capability Enhancement Consortium funded at a level of \$430,000 for fiscal year 2011.

PROGRAM GOALS

The mission of the Maine Space Grant Consortium (MSGC) is to (a) Improve our Affiliates research infrastructure in areas of mutual interest to NASA and the state of Maine; (b) Encourage more students to consider careers in fields of science, technology, engineering, and mathematics (STEM); and (c) Enhance NASA's presence throughout the State of Maine.

A. Goals and Objectives Relevant to NASA Education Outcome 1:

The MSGC's Research Infrastructure, Higher Education and Workforce Development goals are in alignment with activities to achieve Outcome 1. These goals are to: (a) strengthen the Affiliates' STEM research capacity in areas mutually beneficial to NASA and Maine (Research Infrastructure); and (b) to increase participation of Maine undergraduate and graduate students in STEM research conducted by the Affiliates and NASA Field Centers (Higher Education and Workforce Development).

To achieve these goals in a manner that will yield results consistent with Outcome 1, we supported the following objectives:

- a. Support scholarships and fellowships for undergraduate and graduate students at Maine's graduate institutions to conduct STEM related research.
- b. Support scholarships for Maine undergraduate students matriculating at Maine's primary undergraduate institutions to conduct STEM related research.
- c. Increase STEM student enrollment at the University of Maine, University of Southern Maine and the College of the Atlantic by augmenting institutional scholarships to attract highly qualified high school seniors.

- d. Provide undergraduate students with a 10-week research experience at NASA field centers.
- e. Support new STEM course offerings.

A. Goals and Objectives Relevant to NASA Education Outcome 2

The MSGC's Higher Education and Pre-College goals are in alignment with activities to achieve Outcome 2. These goals are to: (a) to increase participation of Maine undergraduate and graduate students in science and engineering research conducted by the Affiliates and NASA Field Centers (Higher Education); and (b) increase participation of Maine K-12 teachers and high school students in STEM activities through professional development activities for in-service and pre-service educators, curriculum development, teacher workshops and student-based programs (Pre-College). To achieve these goals in a manner that will yield results consistent with Outcome 2, we proposed to support the following objectives:

- Support STEM research experiences for High School Juniors and K-12 teachers
- Support a pre-college curriculum/professional development program
- Support existing programs designed to help teachers and school districts acquire and utilize NASA and NASA related educational programs and resources.
- Develop partnerships to leverage and expand K-12 initiatives that connect schools to science and engineering research and educational strengths of the Affiliates

B. Goals and Objectives Relevant to NASA Education Outcome 3

The MSGC's Informal Education goal is in alignment with activities to achieve Outcome 3. The goal is to increase the public's awareness of STEM research, education and activities that are associated with NASA and the Affiliates. To achieve this goal in a manner that will yield results consistent with Outcome 3, we proposed to implement the following objective:

- Support one innovative educational project that uses NASA themes and contents.

PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, OR 3)

Outcome 1 and 2. Luke Saindon, Alex Morrow, Ryan Means, Robert H. Miller, III, Gerard Desjardins and Josh Mueller, Mechanical Engineering students from the University of Maine established "Project URSA", with support through MSGC and its MeSHAP (Maine Student High Altitude Platform) Program. Four of these students have participated in MSGC funded programs prior to establishing Project URSA as described below.

Luke first participated in MSGC activities as an intern at Applied Thermal Sciences, Inc. (MSGC affiliate member) through the ESMD internship program in 2010 (not reported in Space Grant activities). Luke also participated in our (Space Grant), Maine Aerospace Workforce Development Program as an intern at Marshall Space Flight Center in the summer of 2011. Upon his return to Maine in the fall of 2011, Luke participated in our MeSHAP at the University of Maine where he and the other five students above establish Project URSA.

Alex and Ryan also participated in MSGC activities as interns at Applied Thermal Sciences, Inc. through our ESMD internship program before working with the MeSHAP program.

Robert participated in MSGC's Scholarship and Fellowship program at the University of Maine in 2009 working with Dr. Vincent Caccese in a project titled "Analyzing sandwich panels for Orion Rocket"

Project URSA is the design and construction of a sounding rocket designed to achieve an altitude above 100,000 feet using a two stage design. The six students first became involved in MeSHAP through their senior design capstone project a full semester before the capstone classes began, and recruited help from the Mavericks Civilian Space Foundation in California. With MSGC funding through MeSHAP these students have started a foundation of research using rockets at the University of Maine and started an outreach program to high school students.

Project URSA's original goal was to build a two-stage rocket using a hybrid booster motor developed by Luke. The students soon realized that building the hybrid booster would not be feasible in the timeframe that they had to work in, and they were advised by other professionals against the testing of such a large uncharacterized motor in Maine. After mentoring from NASA and the Mavericks, the students were able to think more like systems engineers, and narrow down their project goals. Their revised goal was to compete for the "Carmack Prize" by flying a rocket to a minimum of 100,000 feet and maintaining accurate GPS lock for the entire flight. To reach this goal the students needed to get an FAA class 3 launch waiver to launch a rocket of the size they were building. With guidance from the Mavericks, they were able to successfully get approval and made plans for ground testing at the Mavericks launch site in the dry lakebed of the Black Rock Desert in Nevada. Luke and Gerard, with support from MSGC traveled to Nevada for their first test in March. The team is scheduled to travel out in the summer of 2012 for the launch of the stacked vehicle.

Outcome 1. Four students at the College of the Atlantic, two of which were supported with MSGC scholarship and fellowship program funding (Nicholas Harris and Lisa Bjerke) developed a plan to convert food waste into a fuel known as butanol which can replace both gasoline and heating oil. Their goal is to develop a business (Gourmet Butanol) that turns food and lawn waste into biofuel. Their immediate objective is to construct a facility in Bar Harbor that will utilize restaurant waste to produce enough butanol to replace all of the gasoline and heating oil used by the College of the Atlantic. Their long term goal is to commercialize the process and supply the greater state of Maine with this sustainable and carbon-neutral fuel. These students have received additional funding to continue their project, and have received letters of support from Maine's Senators Olympia Snowe and Susan Collins and from Congressman Michael Michaud. The students have also won a few awards and have received a lot of press coverage both in state (some examples are: the Portland Press Herald, Bangor Daily News, TV channels 2 and 5 and Maine Public Broadcasting Network) and out of state (including the Washington Examiner and the Boston Globe to name a few).

Outcome 1 and 2. MSGC collaborated with the University of Maine (UMaine) and Maine Aerospace Consulting to develop two courses in Aerospace Engineering as the result of our awarded Consortium Development proposal (reported under the Development Program). These two courses coupled with an already existing course, comprised the core of a Concentration in Aerospace Engineering for UMaine Mechanical Engineering majors or a Minor in Aerospace Engineering for students from other engineering disciplines and was the first of its kind in the State of Maine.

With Space Grant funding we were able to develop the final two courses which constitute the final elements of the Concentration in Aerospace Engineering now available within the Mechanical Engineering Department at UMaine. Students seeking this concentration will be required to take both the undergraduate level courses as well as one of the graduate courses. Although final student enrollment data is not yet available for the two graduate level courses, it is encouraging to note that 37 students have already registered for one of the undergraduate level courses scheduled in the fall of 2012, as an elective course. It is expected that these courses will be appealing to a wide range of students.

Outcome 2. Monique Theriault participated in our MERITS (Maine Research Internship for Teachers and Students) Program during the summer of 2011 working in the Chemistry Department at the University of Maine. She continued her work in the lab throughout the academic year, and plans to continue on into the summer of 2012. It is expected that she will have completed enough research at the end of the summer to be included in a publication with her mentor. She will be attending the University of Maine in the fall of 2012 and will major in Molecular Biology and Biochemistry. She plans to continue working with her mentor and expanding her research.

“I can’t help but express how much the (MERITS) opportunity has aided me and opened up doors I wasn’t expecting to be opened until well seasoned as a college student. I have been very pleasantly surprised with all the benefits I am still receiving from doing the MERITS internship. Thank you MERITS and MSGC!!” Monique Theriault

PROGRAM ACCOMPLISHMENTS

Outcome 1: *“Contribute to the development of the STEM workforce in disciplines needed to achieve NASA’s strategic goals”*

MSGC Goal for Scholarships and Fellowships: Increase the participation of Maine undergraduate and graduate students in STEM research conducted by the Affiliates and NASA Field Centers.

Objectives:

1. On an annual basis, at least 38 undergraduate and graduate students (31 tracked and 7 non-tracked) will receive scholarships and fellowships to participate in NASA-related STEM research conducted by the Affiliates and NASA field centers.

- a. Accomplishments: 39 undergraduates and graduate students (23 tracked and 16 non-tracked) have received scholarships and fellowships. ***NOTE: As of this report date, all data has not been collected due to the timing of the awards and the student projects. The number of student awards will increase.***

MSGC Goal for Research Infrastructure: Strengthen the Affiliates science and engineering research capacity in areas mutually beneficial to Maine and NASA.

Objectives:

1. On an annual basis, at least two research collaborations between affiliates and NASA Centers will be seeded.
 - a. Accomplishments: Two research collaborations between affiliates and NASA centers
2. On an annual basis, at least four faculty will be supported in research collaborations between affiliates and NASA centers.
 - a. Accomplishments: Two faculty supported in research collaborations between affiliates and NASA centers (to date, we expect it will increase to at least four)
3. On an annual basis, at least four undergraduates and graduate students (two tracked and two not-tracked) will participate in NASA-related STEM research conducted by affiliates
 - a. Accomplishments: Three undergraduate and graduate students (all not-tracked) participated in NASA-related STEM research conducted by affiliates (to date, we expect it will increase)
4. On an annual basis, at least one new research collaboration between an Affiliate and Minority Serving Institution will be seeded
 - a. Accomplishments: Zero **NEW** collaborations were conducted, but **ONE** existing collaboration continues
5. On an annual basis, at least two faculty will be supported in the research collaborative between an affiliate and a Minority Serving Institution.
 - a. Accomplishments: Zero faculty was supported – see above
6. On an annual basis, at least two undergraduate and graduate students will participate in a collaboration with a Minority Serving Institution
 - a. Accomplishments: Zero students participated in a collaboration with a Minority Serving Institution – see above

MSGC Goal for Higher Education: Increase participation of Maine undergraduate and graduate students in science and engineering research conducted by the affiliates and NASA Centers

Objectives:

1. On an annual basis, at least five undergraduate and graduate students (three tracked and two not-tracked) will participate in NASA-related STEM research conducted by the affiliates.
 - a. Accomplishments: 36 students participated (9 tracked, 27 not-tracked) in NASA-related STEM research conducted by affiliates
2. On an annual basis, at least two courses that integrate NASA-related resources into STEM disciplines will be developed or improved

- a. Accomplishments: Two new courses have been developed
- 3. On an annual basis, at least four undergraduate students (all tracked) will participate in summer research experiences in NASA-related STEM research conducted at Maine Technology-based companies and/or NASA Field Centers
 - a. Accomplishments: Six student participants (five tracked, one non-tracked) have been placed in research experiences at NASA Field Centers

Outcome 2: *“Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers and faculty”*

MSGC Goal for Pre-College: Increase participation of Maine K-12 teachers and high school students in STEM activities:

Objectives:

- 1. On an annual basis, at least six middle and high school teachers will participate in summer research experiences in NASA-related STEM research
 - a. Accomplishments: Zero teacher participants. *NOTE: MSGC is assessing the teacher portion of this program. We have not had successful responses to this program from teachers, although the student-based portion of the program is extremely successful and is continuing to grow. We are in the process of determining what we can do to modify the teacher portion to make it successful.*
- 2. On an annual basis, at least four high school juniors will participate in summer research experiences in NASA-related STEM research
 - a. Accomplishments: Five high school juniors will participate in summer research experiences. **As of this report date, the program is not complete and all the data has not been received. This number is expected to increase to 12**
- 3. On an annual basis, at least two new or improved curricula that uses NASA themes and content will be introduced in Maine K-12 schools
 - a. Accomplishments: Zero new curriculum has been developed. In this year, our funding for our pre-college program was directed to a project that involved teachers, but did not involve developing new curricula. This project reached 20 Maine K-12 teachers
- 4. On an annual basis, at least two middle school teachers will use NASA contents and themes to enhance their STEM curricula
 - a. Accomplishments: Two teachers will use NASA content.
- 5. On an annual basis, at least 40 middle school students will be exposed to NASA-mission related activities, STEM disciplines and careers
 - a. Accomplishments: Over 3000 middle and high school students have been exposed to NASA related activities

Outcome 3: *“Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA’s mission”*

MSGC Goal for Informal Education: Increase the public’s awareness of STEM research, education and activities that are associated with NASA and the affiliates

Objectives:

1. On an annual basis, at least one informal education activity that uses NASA themes and content will be supported
 - a. Accomplishments: One informal education activity has been supported.
2. On an annual basis at least 50 students will have a better appreciation of STEM and NASA
 - a. Accomplishments: We could not track the exact number of students this activity served due to the nature of the program and privacy regulations. We expect that we met or exceeded this objective

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Student Data and Longitudinal Tracking: Number of student participants who are:

| | |
|---|----|
| Employed by NASA | 5 |
| Employed by Aerospace Contractors | 5 |
| Employed by Universities | 1 |
| Employed by other education institutions | 7 |
| Employed in other STEM fields | 47 |
| Pursuing advanced education in NASA-related disciplines | 49 |
| Underrepresented | 18 |

MSGC longitudinally tracks students that receive a significant award or benefit from the award/experience. Notices are sent out to these students twice annually requesting information on their academic and workforce status as well as data on publications, presentations, and proposals submitted to other funding agencies, as a result of their Space Grant award.

- Course Development:

| | |
|----------------|---|
| New courses | 2 |
| Revised course | 0 |

Two new Graduate level courses were developed at the University of Maine for integration as electives into the Mechanical Engineering Department. These courses constitute the final elements of the Concentration in Aerospace Engineering at the University of Maine.

“Aircraft Flight Dynamics and Control” MEE 547

“Spacecraft Orbit and Attitude Dynamics and Control” MEE 548

- Diversity: Data for 2011:

Two underrepresented students (in our scholarships and Fellowship program), which constitutes 3% of total student participation.

24 female participants (combination of all programs), which constitutes 31% of the total student participation.

- Matching Funds: Total matching funds for 2011 is \$320,000, which consists of:

| | |
|---------------------|-----------|
| Academic Affiliates | \$265,000 |
| Non-profit | 2,507 |
| Industry | 2,500 |
| Other non-federal | 10,000 |
| Lead institution | 39,993 |
- Minority-Serving Institutions: There are no minority serving institutions in the State of Maine. MSGC implemented a collaborating program with California State Long Beach (CSLB), Department of Mechanical and Aerospace Engineering (minority serving institution) and the University of Maine (UMaine), Department of Electrical and Computer Engineering in 2008. The project was extended through 2010. The collaboration resulted in a proposal submitted to the NASA EPSCoR MSI program by UMaine (lead institution) with CSLB as the minority serving institution, which was recently awarded. We did not have a new collaboration in 2011, although we continue to provide support (not financial) to the UMaine/CSLB collaboration. Going forward, we intend to continue exploring opportunities with additional minority serving institutions.
- NASA 2010 Education Priorities: “Accomplishments related to the “Current areas of emphasis” stated in the 2010 solicitation.

Authentic, hands-on student experiences in science and engineering disciplines..:

MSGC’s Scholarship and Fellowship Program (page 4), Research Infrastructure (page 5), Higher Education (pages 5-6) and MERITS program (page 6 under pre-college programs) apply to this priority area

Engage middle school teachers in hands-on curriculum enhancement capabilities through exposure to NASA scientific and technical expertise..

MSGC’s MERITS program (page 6 under pre-college programs) apply to this priority area

Summer opportunities for secondary students on college campuses with the objective of increased enrollment in STEM disciplines or interest in STEM careers

MSGC’s MERITS program (page 6 under pre-college programs) apply to this priority area

Aeronautics research – research in traditional aeronautics disciplines; research in areas that are appropriate to NASA’s unique capabilities; directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen)

MSGC’s Research Infrastructure Program (page 5) apply to this priority area

Enhance the capacity of institutions to support innovative research infrastructure activities to enable early career faculty to focus their research towards NASA priorities.

a. MSGC’s Research Infrastructure Program (page 5) apply to this priority area

IMPROVEMENTS MADE IN THE PAST YEAR

MSGC improved its Higher Education Program by focusing our efforts to grow the newly established Maine Student High Altitude Platform (MeSHAP) Program.

MSGC received 2010 Consortium Development funding that supported our initial efforts to develop the MeSHAP Program (reported in the Development Program). With this funding we proposed to adapt the Louisiana Space Grant Consortium's (LaSPACE) "Scientific Ballooning Course" for both sounding balloon and rocket payloads to provide undergraduate students at the University of Maine (UMaine), the University of Southern Maine (USM) and Maine Maritime Academy (MMA) with experience in how to design, develop, and operate an aerospace project.

With the success of this project, we established the MeSHAP as a permanent Space Grant program by allocating funds to further enhance the experiences of both faculty and students in the development of multidisciplinary science and engineering payloads with the intention that groups will participate in NASA-sponsored student competitions as well as NASA missions.

Each institution has implemented its own unique piece to the MeSHAP program. For example, MMA has built and trained students for a balloon system capable of at-sea deployment and recovery from a ship. USM has incorporated biology and toxicology experiment payloads to their balloon to be later analyzed. This research offers students a unique interdisciplinary opportunity as they engage in biological and mechanical experimental design. USM is collaborating with NASA Johnson Space Center on this program. UMaine incorporated this project as a new course (reported under Development Program), implemented a successful rocketry program and is now leading the way in becoming a support system for other institutions in the state wanting to become involved in high altitude ballooning.

In addition to this accomplishment, MSGC was awarded a NASA Education Cooperative Agreement to pilot a K-12 Astrobiology Scientific Ballooning program (a K-12 element of the MeSHAP program now in its final year). Funding from these sources has provided us the opportunity to build the state's infrastructure for scientific ballooning and sounding rockets as a mean to inspire student's interest, K-12 and undergraduates, in STEM careers. By generating this interest and excitement around student-based high altitude projects, Maine students will be better prepared to participate in national competitions (see page two of this report "Program/Project Benefit to Outcome 1,2, or 3 success story about Project URSA)

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

Higher Education Affiliates

- Bates College, 4-year or above, Private, Baccalaureate College-Liberal Arts. Participates (faculty and students) and volunteers in multiple MSGC programs and activities.
- Bowdoin College, 4-year or above, Private, Baccalaureate College-Liberal Arts. Conducts scholarship/fellowship program, participates and volunteers in multiple MSGC program and activities.
- Colby College, Waterville, 4-year or above, Private, Baccalaureate College-Liberal Arts. Participates (faculty and students) and volunteers in multiple MSGC programs and activities
- College of the Atlantic, Bar Harbor, 4-year or above, private, Baccalaureate College-Liberal Arts. Conducts scholarship programs, participates and volunteers in multiple MSGC program and activities.
- Embry-Riddle Aeronautical University, 4-year (still nurturing)
- University of Maine, Orono, 4-year or above, Public, Doctoral/Research-Extensive, member of the Board of Directors, conducts scholarship and fellowship programs, participates and volunteers in multiple MSGC program and activities
- University of Southern Maine, Portland, 4-year or above, Public, Master's Colleges and Universities II, member of the Board of Directors, conducts scholarship and fellowship programs, participates and volunteers in multiple MSGC program and activities
- University of New England, Biddeford, 4-year or above, Private, Master's Colleges and Universities II. Conducts Scholarship/Fellowship Program, participates (faculty and students) and volunteers in multiple MSGC programs and activities.
- Maine Maritime Academy, Castine, 4-year or above, Public, Specialized Institutions. Conducts Scholarship/Fellowship Program, participates (faculty and students) and volunteers in multiple MSGC programs and activities.

Non-Higher Education Affiliates

- Bigelow Laboratory for Ocean Sciences, Boothbay Harbor, Marine Research and Education, member of the Board of Directors. Participates and volunteers in multiple MSGC program and activities.
- Gulf of Maine Research Institute, Portland, Private not-for-profit, Marine Research and Education
- Maine Manufacturing Extension Partnership, Augusta, Private not-for-profit, Manufacturing Extension, member of the Board of Directors. Participates and volunteers in multiple MSGC program and activities.
- Applied Thermal Sciences, Sanford, High Tech Small Business, member of the Board of Directors. Participates and volunteers in multiple MSGC program and activities.
- Maine Mathematics and Science Alliance, Augusta, Private not-for-profit, Education, member of the Board of Directors. Participates and volunteers in multiple MSGC program and activities
- The Challenger Learning Center of Maine, Bangor, Private not-for-Profit, Education. Participates and volunteers in multiple MSGC program and activities

- BioAnalyte, Portland, Industry. Participates and volunteers in multiple MSGC program and activities
- Island Astronomy Institute, Private not-for-Profit, Education. Participates and volunteers in multiple MSGC program and activities
- Lockheed Martin, Industry. Participates and volunteers in multiple MSGC program and activities